"PRELIMINARY"
LADOTD CANTILEVER SHEET PILE DESIGN GUIDELINES

GENERAL CONSIDERATIONS: Sheet pile retaining walls are designed using earth pressure theories based on homogeneous layers of soil. However the structure of natural soils is often very complex. Therefore, it is essential that a complete subsurface investigation be performed using soil borings to determine a representative profile of the subsurface soil at the location of the wall. Laboratory soil testing should be performed to determine the engineering properties necessary for the design of sheet pile retaining walls using short term and long term criteria. The following guidelines should be used along with engineering judgment to design a sheet pile retaining wall.

WALL HEIGHT AND GEOMETRY: The maximum sheet pile wall height shall be used for the design of a sheet pile wall. A table should be shown in the plans indicating top of wall elevation, ground elevation (dredge line), and stationing along the sheet pile wall, at maximum intervals of 50 feet. A plan view of the sheet pile wall shall be shown in the plans detailing offsets from the centerline, and the beginning and ending limits of the wall.

RETAINED BACKFILL SOIL: The retained backfill soil shall be defined as the soil located above the dredge line. The retained backfill soil may be composed of newly placed embankment material, existing embankment material, a cohesive material, or a granular material. Soil boring data should be used to determine the soil properties necessary for the design of the sheet pile wall. If soil boring data is not available and the retained backfill soil is composed of new embankment materials, the following soil design parameters shall be used for design.

NEW EMBANKMENT

Short Term: (undrained shear strength)

- A cohesion (c) of 500 psf, a wet unit weight (γ_{wet}) of 120 pcf, an internal soil friction angle (ϕ) of 0 degrees, and a wall friction angle (δ) of 0 degrees.

Long Term:

- A cohesion (c) of 0 psf, a wet unit weight (γ_{wet}) of 120 pcf, an internal friction angle (ϕ) of 25 degrees, and a wall friction angle (δ) of 11 degrees.

If the retained backfill is composed of existing embankment materials or a cohesive material, and the soil boring data is unavailable for these materials, the following soil design parameters shall be used for design.

EXISTING EMBANKMENT MATERIAL / COHESIVE MATERIAL

Short Term: (undrained shear strength)

- A cohesion (c) of 400 psf, a wet unit weight (γ_{wet}) of 120 pcf, an internal soil friction angle (ϕ) of 0 degrees, and a wall friction angle (δ) of 0 degrees.

Long Term:

- A cohesion (c) of 0 psf, a wet unit weight (Υ_{wet}) of 120 pcf, an internal friction angle (ϕ) of 23 degrees, and a wall friction angle (δ) of 10 degrees.

If the retained backfill is composed of granular materials, the granular backfill material should be tested to determine soil properties necessary for the design of the sheet pile wall. If soil boring data or soil testing is unavailable for these materials, the following soil design parameters shall be used for design.

GRANULAR MATERIAL

- A cohesion (c) of 0 psf, a wet unit weight (Υ_{wet}) of 120 pcf, an internal friction angle (ϕ) of 27 degrees, and a wall friction angle (δ) of 10 degrees.

FOUNDATION SOIL: The foundation soil shall be defined as the soil located below the dredge line. Soil boring data should be used to determine the soil properties necessary for the design of the sheet pile wall. If soil boring data is not available, the following soil design parameters shall be used for design.

Short Term: (undrained shear strength)

- A cohesion (c) of 400 psf, a wet unit weight (Υ_{wet}) of 120 pcf, an internal soil friction angle (ϕ) of 0 degrees, and a wall friction angle (δ) of 0 degrees.

Long Term:

- A cohesion of 0 psf, a wet unit weight (Υ_{wet}) of 120 pcf, an internal friction angle (ϕ) of 23 degrees, and a wall friction angle (δ) of 10 degrees.

WALL FRICTION ANGLE: The wall friction angle (δ) should be limited to a maximum angle of 11 degrees for granular soils.

WALL LOADS: Sheet pile walls shall be designed to resist hydrostatic loads, traffic loads, and surcharge loads in accordance with the following guidelines. The lateral earth pressures produced by these loads should be used to develop the design lateral earth pressures.

Hydrostatic Loads: Sheet pile walls shall be designed to resist hydrostatic loads when applicable. When sheet pile walls are subject to rapid draw down conditions due to river stage fluctuations, the maximum differential hydrostatic pressure shall be computed using the high-water level for the channel. When sheet pile walls are located along rivers, canals, and other bodies of water, a minimum differential hydrostatic pressure equal to 3.3 feet (1m) of water shall be used for design. This load shall be applied at the high water level. The channel scour elevation shall be used as the design elevation for the dredge line. (5.8.12.3)

Traffic Loads: When traffic loads are applied over the active zone of the retained backfill soil, the lateral earth pressure for design shall be computed using a 250 psf uniformly distributed load. (5.5.2)

Surcharge Loads: The effects of a soil surcharge load shall be used to develop the lateral earth pressures. For a uniform soil surcharge load, the design lateral earth pressures may be computed by treating the surcharge as an equivalent height of backfill.

TRAFFIC BARRIERS: When traffic barriers are located near a sheet pile wall, a detail of the traffic barrier dimensions and location relative to the sheet pile wall shall be shown in the plans.

Impact Loads: If the outer edge of an unrestrained traffic barrier is located less than 3.0 feet from the back of the sheet pile wall, a horizontal impact load of 2000 pounds per linear foot of wall shall be used for design. The impact load should be applied to the top of the sheet pile wall. (5.8.12.2)

If the traffic barrier is anchored, no impact load should be used for design.

ALLOWABLE WALL DEFLECTION: The allowable sheet pile wall deflection shall be measured from the top of the wall and must be used as a design constraint. The following equation shall be used to compute the allowable wall deflection at the top of a sheet pile wall for design wall heights less than or equal to 15 feet.

Allowable Wall Deflection (inches) = (.40) * (H)

H = design height of the sheet pile wall in feet measured from the dredge line (where H ≤15 feet)

For sheet pile walls with a design height greater than 15 feet, a maximum sheet pile wall deflection of 6.0 inches at the top of the wall shall be used for design.

DRAINAGE: Hydrostatic pressures behind the sheet pile wall may be controlled by the installation of a drainage medium behind the sheet pile wall facing with outlets placed at or near the base of the wall. Drainage outlets shall be placed every 50 feet. (5.6.3)

ALLOWABLE STRESS: The allowable stress for steel sheet piles shall be 55% of the minimum yield stress of the steel.

GLOBAL STABILITY: A minimum safety factor of 1.3 for the global stability of the sheet pile wall is required for both sliding and circular failure mechanisms.

SAFETY FACTORS: A factor of safety of 1.50, FS_{sheet}, shall be used to design the steel sheet pile retaining wall. This safety factor should be applied to the following

conditions. The computed penetration depth must not be increased when using this method. (NHI 13236)

Sheet Piling in Granular Soils: When sheet piles are in granular soils, a factor of safety of 1.50, FS_{sheet}, should be applied to the passive earth pressure coefficient, K_p, to determine the design lateral earth pressures. Therefore, $K_{p\text{-}sheet}$ shall be used to determine the design lateral earth pressures.

$$\mathbf{K_{p\text{-}sheet}} = K_p \,/\, FS_{sheet}$$

Sheet Piling in Cohesive Soils: When sheet piles are in cohesive soils, a factor of safety of 1.50, FS_{sheet}, should be applied to the unconfined compressive strength of the soil, qu. Therefore, $\mathbf{qu_{\ sheet}}$ shall be used for design.

$$\mathbf{qu_{\ sheet}} = qu \,/\, FS_{sheet}$$

ACCEPTABLE DESIGN PROCEDURES: Steel sheet pile walls may be designed using the following design procedures *only*.

AASHTO, USS STEEL SHEET PILING DESIGN MANUAL, NHI COURSE NO.13236, & CWALSHT

PLAN DETAILS: The following information should be shown in the plans when sheet pile walls are to be used on a construction project.

A. Plan and Profile Sheet:

(1) Plan view of wall indicating beginning and ending limits.
(2) Horizontal and vertical alignment
(3) Table showing top of wall and ground elevation(dredge line) at maximum intervals of (50 feet) along the sheet pile wall
(4) Soil boring locations
(5) Location and elevation of temporary barriers, utilities, signs, etc., and the loads imposed by each such appurtenance.
(6) Design high water level, mean high water level, low water level, flood stage, and draw down conditions where applicable.

(7) Construction constraints such as phased construction sequence, right-of-way, construction easements, etc.
(8) Wall quantity (for informational purposes)
(9) General notes
(10) In-situ soil characteristics (predicted settlement, etc.)
(11) Drainage details if applicable

B. Sheet Pile Wall Details showing

(1) Temporary traffic barrier geometry next to sheet pile wall
(2) Conflicts or obstruction between the sheet pile wall and piles, drainage structures, utilities, etc.